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**Note.*—Additional copies in pamphlet form can be obtained, free of charge, on application to the Rubber Research Scheme, Neboda. Translation into Sinhalese is being arranged.

OIDIUM LEAF DISEASE IN CEYLON IN 1934

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FOREWORD

IN view of the attention which local Rubber growing interests have recently devoted to Oidium leaf disease, as evidenced by correspondence in the local Press and by numerous requests received at the Research Laboratories for advice and consultative visits, it seems desirable to record the views of the Research Scheme in regard to the present status and economic significance of Oidium in Ceylon. That there is good cause for the interest being evinced in this disease is shown by the fact that reports of attacks of increased severity have been received from the following districts, representing between them most of the Rubber in Ceylon: Kelani Valley, Ratnapura, Kalutara, Galle, Matale, Galagedera, Kurunegala, Haputale, Badulla and Madulsima.

THE PRESENT POSITION

In considering the present position of the disease in Ceylon a distinction must be drawn between mid-country and low-country districts. In the former the climatic conditions favour the fungus rather than the host, and at elevations of about 2,000 feet Oidium has caused serious defoliation for some years. During recents years an extension of the severely affected areas to somewhat lower elevations has become evident, and in 1934 there have been severe attacks down to elevations of about 1,000 feet.

In the main low-country districts Oidium has been present every year since 1925, and the fact that until 1934 it showed no marked signs of increased severity was attributed mainly to the relatively high temperatures which are known to be unfavourable to spore formation. During the recent refoliation, however,

the disease has caused far more leaf-fall than in any previous year, and on many estates, notably in the Kalutara district, the general appearance of the foliage has suffered considerably. It is, in fact, the first year in which the effects of Oidium have been evident by looking at the foliage as a whole rather than by examining individual trees.

FUTURE DEVELOPMENTS

In previous reports attention has been drawn to the serious nature of the disease at the highest elevations, the fear being expressed that unless control measures were adopted the economic existence of such areas was menaced. There is no doubt that these prognostications are in course of fulfilment, though the deterioration has been partially masked by the cessation of tapping on most properties of this nature during the years of depression. So long as the fungus confined its greatest activities to elevations of about 2,000 feet the disease was relatively unimportant to the Ceylon industry as a whole, but the extension of severe attack down to an elevation of about 1,000 ft. involves the whole area of mid-country Rubber and, indeed, some portions of estates in districts classed as low-country. It is important therefore to endeavour to forecast the future course of development of the disease in this zone of elevation.

It has been the general experience that once Oidium has become really severe on any particular estate the tendency is for increasing damage to be caused in successive years, and an improvement in the present position is considered improbable unless control measures are widely undertaken. It is impossible to avoid the inference that in the absence of any treatment the trees must show a similar deterioration (albeit at a slower rate) to that demonstrated at the highest elevations. Fortunately an effective and reasonably cheap means of control is available in the form of sulphur dusting, and the key to the situation would appear to lie in the organised adoption of this treatment before irreparable damage has been done. It may be pointed out that Rubber is not alone in its need for routine control measures, for numerous economic crops are dependent on the systematic application of fungicides for their existence on a profitable basis.

The position as regards low-country estates is more obscure. An endeavour to predict the future course of events must be based on a consideration of the causes of this year's severe attack, and on this point there is some divergence of opinion. If the view is accepted that unusual weather conditions have been solely

responsible, then a recurrence is not to be expected in a normal year. One hopes that this may be the true explanation, but a study of weather conditions as recorded at these laboratories on Culloden Estate does not reveal any marked abnormality in either rainfall, humidity or temperature during or immediately before the period of greatest fungal activity. Stress has been laid by some correspondents on the wet weather experienced during refoliation, but our records show that in this one locality, at least, there have been fewer wet days and a drier atmosphere during February and the first week in March this year than during the corresponding period in 1933, and it was clear before the March rains set in that the disease was unusually severe. Moreover, our knowledge of the relationship between the activity of the fungus and meteorological conditions does not suggest that a high rainfall is usually associated with an intense attack. It is probable that the absence of sunlight delays the maturation of the leaf so that it remains longer in the vulnerable pendant condition, but in other respects wet weather favours the host plant rather than the parasite. The difficulty of assessing the importance of recent weather conditions in relation to Oidium attack from one set of records is acknowledged, and the suggestion that conditions have been unusually favourable for the fungus in almost every district in the Island can be neither confirmed nor denied. Whatever the true facts of this matter may be there are grounds for suggesting that there has been an advance on the part of the fungus which is not wholly attributable to the weather.

It is somewhat disturbing to note that whereas in previous years the fungus reverted to a passive condition in April, in 1934 it has been observed in one low-country locality, at least, to be in an active sporulating condition up to the middle of June. This is a step towards mid-country conditions and suggests a process of acclimatisation. The extent to which an organism can become adapted to environmental conditions without the evolution of a genetically new strain is a somewhat dangerous question on which to express an opinion. Observations show that spore formation has gradually become more prolific in the low-country in recent years, but whether this is due to a process of acclimatisation or, more simply, to an increase in the actual quantity of the fungus present, or to both factors, is uncertain. Whatever may be the true explanation, one fears that the balance between parasite and host is gradually being weighted in favour of the former so that, apart from annual fluctuations due to weather conditions, there

may be a tendency towards increased severity. It is considered unlikely that a prolonged attack of the severest nature will ever occur in the low-country, but the comfortable assurance that a disease will never assume a serious aspect because the host plant is growing under favourable conditions is unfortunately falsified by history.

To sum up this section, it is believed that in the absence of control measures the disease will become increasingly severe at mid-country elevations, while a similar tendency in low-country districts is not improbable.

THE ECONOMIC ASPECT

One of the main causes for the great damage wrought by this disease under the worst conditions is the fact that the fungus is active almost throughout the year. The trees are therefore subjected to several abnormal defoliations each year, and the injury is soon reflected in a dieback of twigs and branches and a greatly decreased rate of bark renewal. Measurements made in two adjacent fields on an estate in Matale showed, for example, that the rate of bark renewal was about 40 per cent. greater in a field in which the disease had been controlled by sulphur dusting than in the undusted area.

Although the inevitability of ultimate decreases in crop in such severely defoliated areas is almost self-evident, actual figures are naturally more convincing. Such figures are available as the result of careful yield records kept by the Rubber Research Scheme in a severely affected area in the Matale District. It is sufficient for the purposes of this report to state that the records show an alarming fall in crop in a field which formerly gave a very satisfactory yield per acre. Numerous reports of yield declines have been received from other estates.

The position in the low-country is somewhat different. One may safely assert that until 1934 the damage caused by the disease was unimportant, and it is probably only on a minority of estates that this year's attack has been sufficiently severe to have an appreciable effect on bark renewal or yield. In contrast with the higher elevations the fungus remains active for a limited period (until 1934 the period was usually 6 to 8 weeks), and defoliated trees are able to recover by putting out a second crop of leaves which remain relatively healthy. This secondary foliage, however, is produced at the cost of food reserves, and it is clear that if a substantial proportion of the trees becomes defoliated

the estate, as a whole, must eventually suffer. A considerable lag as regards an influence on yield is to be expected, but any circumstance which is detrimental to bark renewal must ultimately be detrimental also to yield.

The danger lies in the possibility of the disease becoming increasingly severe in the low-country. From the discussion in the preceding section it is clear that this matter remains in doubt, but it can at least be stated that the disease is unlikely to advance so rapidly as to cause serious damage in one season. While control measures in mid-country are considered essential, in most low-country localities a "wait-and-see" policy is advocated.

CONTROL

Experiments on the control of Oidium have been conducted continuously by the Rubber Research Scheme since 1929. The results have been published from time to time, and it is sufficient to state here that the only effective remedy which has been discovered is dusting with finely divided sulphur powder. Experiments have established the efficacy of sulphur dusting in preventing most of the defoliation, and despite certain practical difficulties and objections, the treatment is considered to be applicable on an estate scale under normal conditions. The cost will vary according to the intensity of the attack, but an average figure is Rs. 5/- per acre per annum excluding the cost of the machine (about Rs. 1,200/-). The treatment must be undertaken every year, but it is probable that if all neighbouring estates were to co-operate the fungus would gradually be brought under control and the cost thereby diminished. A practical account of the treatment is given elsewhere in this issue. Although further experiments may result in an improvement of the method, (it is possible, for example, that large blocks could be more effectively dusted by aeroplane) sulphur dusting can be regarded as a proved treatment. It may be mentioned that spraying with sulphur, in one form or another, is the standard remedy for all similar diseases caused by powdery mildews.

Early attention was directed to the possibility of checking the disease, or minimising the effects, by means of artificial manuring. Experimental plots were laid out in a severely affected area in Matale, heavy dressings of nitrogenous and potassic fertilisers being applied in two successive years. The results were entirely negative, and it may be concluded that no cultural measure which does not involve a direct attack on the fungus will be of any appreciable value in the worst areas.

The effect of manure on the extent of defoliation in mildly diseased areas is somewhat uncertain. One of the results of cultivation is to delay wintering. Now in the low-country Oidium does not usually become fully active until the latter half of February with the result that late wintering trees put on their new foliage during the period in which the fungus is active, and therefore become defoliated. Early winterers, on the other hand, have matured their leaves early in February and so escape attack. It is possible, therefore, that manuring would actually increase the amount of damage by delaying refoliation until the period in which the disease is most active. On the other hand, the effect of manure is also to speed up the process of refoliation so that the young leaves are in a vulnerable condition for a shorter period of time, and good agricultural conditions will also assist the trees to recover from defoliation. It is difficult to know how these factors will balance out, but it is significant that poor properties, by wintering early, often escape the Oidium which attacks neighbouring estates. Manuring alone cannot be considered a remedy for the disease, though in conjunction with sulphur dusting it will doubtless be of great benefit. Recent recommendations for the control of Oidium made by the Research Scheme in reply to estate enquiries may be summarised by stating that sulphur dusting has been advocated on mid-country estates which are otherwise capable of giving satisfactory yields, whereas it has been suggested that in the low-country the trend of future developments should be awaited before embarking on the treatment.

FUTURE INVESTIGATIONS

It may be useful to point out that the life history and characteristics of the fungus are already well known as the result of field and laboratory investigations in the various producing countries, and that the Research Scheme has had experience of sulphur dusting over the past five years. There is admittedly scope for improvements in the technique of the dusting operation and it is considered that investigations in this direction can best be carried out in connection with routine dusting operations on estates. The main requirement at the present time appears to be to familiarize Producers with the method of control by means of demonstrations of the treatment in different districts.

REFERENCES

In conclusion, attention is drawn to the following list of publications in which most of the considerations discussed above are presented in detail:

Rubber Research Scheme *Quarterly Circular*, Vol. 6, Part 2 1929.

Rubber Research Scheme *Quarterly Circular*, Vol. 7, Part 2 1930.

Rubber Research Scheme *Quarterly Circular*, Vol. 7, Part 4 1930.

Rubber Research Scheme *Quarterly Circular*, Vol. 8, Parts 2 & 3. 1931.

Rubber Research Scheme *Quarterly Circular*, Vol. 8, Part 4 1931.

Rubber Research Scheme *Quarterly Circular*, Vol. 10, Part 1, 1933.

THE SULPHUR DUSTING TREATMENT FOR OIDIUM

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FOREWORD

IN previous reports published in the *Quarterly Circular* (1, 2 & 3) details have been given of the series of experiments conducted by the Research Scheme on sulphur dusting as a means of controlling Oidium leaf disease. Until recently, however, the disease had only assumed a serious aspect on certain of the higher estates in mid-country districts, and for the majority of Proprietors and Superintendents the investigations may have held only an academic interest. During the last two years, and more notably in 1934, there has been a considerable extension of the more severely affected areas, and this unfortunate development, coupled with the improved market for the commodity, has focussed attention on the disease and measures for its control. Several estates are known to be contemplating the adoption of the sulphur dusting treatment during the 1935 refoliation season, and this article is intended to give a purely practical description of the methods employed, together with any hints and suggestions which may be useful to those undertaking the work for the first time.

UNDER WHAT CIRCUMSTANCES SHOULD DUSTING BE UNDERTAKEN?

It is not the purpose of this article to discuss in detail the economic aspect of the disease, or under what circumstances the sulphur dusting treatment may be considered a sound proposition. Previous papers (4 and 5), as well as an article in the present issue, deal with these matters, and the advisory services of the Scheme are always available in individual instances. To summarise recent recommendations in reply to estate enquiries, we have not hesitated to advocate sulphur dusting on severely affected mid-country estates which are otherwise capable of giving satisfactory yields, but it has been suggested that in the wet low-country districts, where defoliation is less serious, the trend of future developments should be awaited before embarking on the treatment.

EQUIPMENT REQUIRED

(1). *Machine.*—The sulphur is applied to the trees from a power dusting machine. There are several suitable outfits on the market but the principle is in all cases the same. A fan is driven at high speed by a small air-cooled, two-stroke, petrol engine, and into the fan chamber or the resultant air stream sulphur is admitted from a hopper, and thus blown up through a chimney outlet. The rate of delivery can be adjusted by opening or shutting the aperture through which the sulphur falls. The whole forms a compact unit which is slung on two poles and carried by 4 to 8 men according to the nature of the ground. The weight, of course, varies with different types, but the machines in most general use weigh rather less than 2 cwt. empty.

When these machines were first designed the question of fitting wheels received consideration. With the rough paths general on hilly land it was felt that a fixed wheel or wheels would be of little value especially as the machine must often be carried off the paths. If, however, the existing paths were to be improved and new traces made in strategic positions, the machine could well be placed on some form of cart or barrow and lifted off when necessary. This matter is further discussed below under the heading "Roads".

For particulars of individual outfits application to the Scheme is invited.

(2). *Sulphur.*—The first essential of a dusting sulphur is fineness of sub-division, ordinary "flowers of sulphur" being too coarse a form. There is a large number of commercial dusts marketed, and for present purposes two types may broadly be distinguished:

(a). Sulphur from the Kawah Poetih volcanic deposits in Java, the purified article being sold in two grades as "Flotate" Sulphur.

(b). Specially prepared, free-flowing dusts. This type of product is represented in Ceylon by "Olite" and "Aero-Smoke" Sulphurs.

For the control of Oidium in past years "Flotate" Sulphur has been much favoured, mainly on account of its low price and small particle size. The powder, however, contains a certain proportion of free acid which renders it hygroscopic, and the bulk of the moisture must be evaporated or otherwise removed

before the sulphur is suitable for use. Recent experience indicates that the degree of hygroscopicity is liable to vary with different shipments, and whereas one consignment may be easily dried by a few hours' exposure to the sun another may need the addition of quicklime before a sufficiently free-flowing dust can be obtained.

The procedure for drying "Flotate" Sulphur is as follows: spread it out on a hot sunny morning on "tagarams" or old sacking, continually turning the sulphur over until it no longer masses when squeezed in the hand. Small lumps should be broken up by pressing the sulphur through a sieve. If a satisfactory free-flowing dust is not obtained after a full day's exposure to a hot sun, the sulphur should be mixed with freshly burned, powdered quicklime in the proportion 10 to 20 parts of sulphur to 1 part of lime. The sulphur should be used within a few days of drying.

Recommendations regarding the use of this type of sulphur are at present being deferred pending the receipt of further advices from Java. It is understood that the manufacturers are endeavouring to improve the drying properties.

Such an article as "Olite" or "Aero-Smoke" Sulphur can be used without any preliminary treatment, the tendency for the particles to adhere together, or "ball", being overcome by the admixture of a small proportion of an inert material. Both sulphurs mentioned above have been found to possess excellent cloud-forming properties.

Exact data regarding the relative merits of the various grades of sulphur are at present lacking, but it is hoped that information may become available as the result of comparative trials to be carried out on a large scale in 1935.

THE DUSTING OPERATION

Field Technique.—The machine throws up a cloud of sulphur which is carried by whatever breezes may be blowing, and the essence of the technique of sulphur dusting lies in the intelligent use of such air currents. If the air is quite still the sulphur rises high above the tree tops and gradually settles again, and since the dust is not carried any appreciable distance the process is obviously very slow. A strong wind is unfavourable unless blowing down a steep slope, since it prevents the sulphur from rising sufficiently high. This is well illustrated in Plate III. The ideal conditions are given by a slight steady breeze which permits the sulphur to rise to the required height

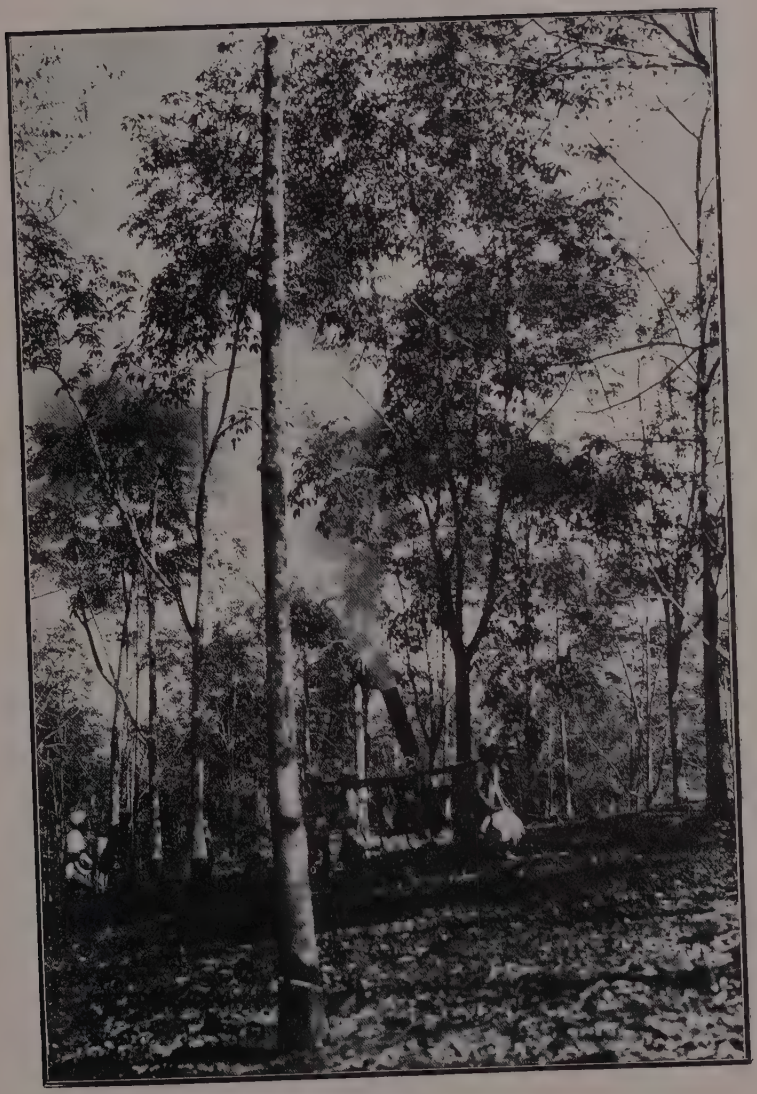

Plate I.

Dusting in progress, machine being carried. Sulphur rising to tops of rather small trees.

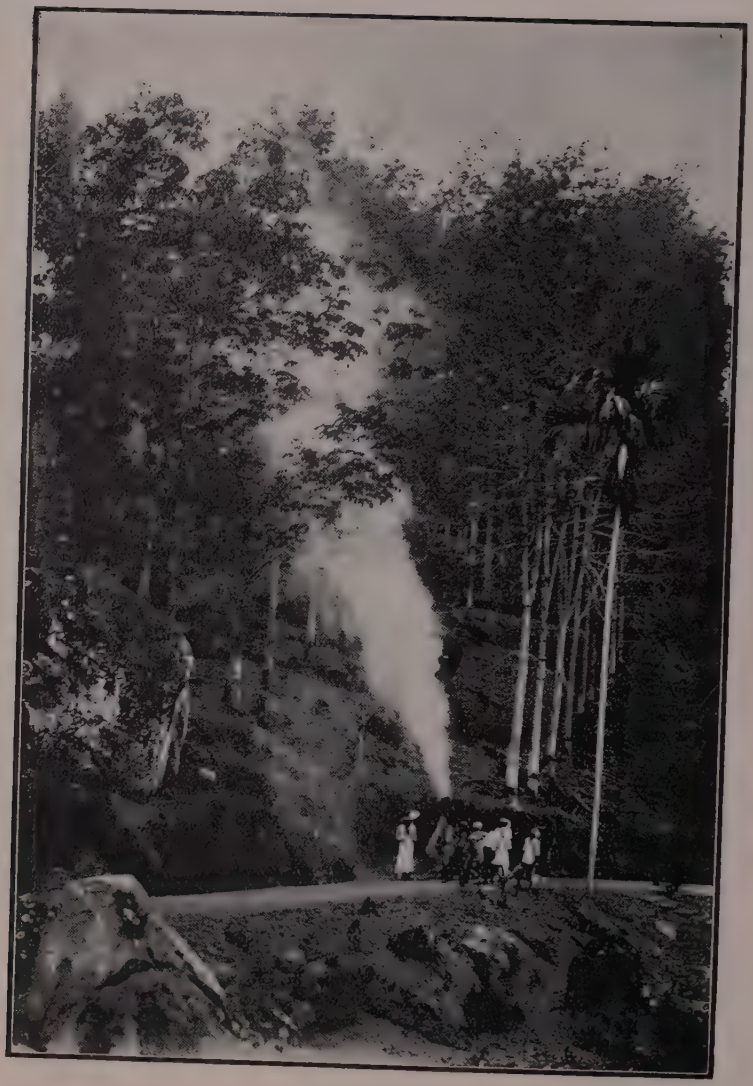

Plate II.
Dusting in progress, machine at rest.
Wind conditions ideal.

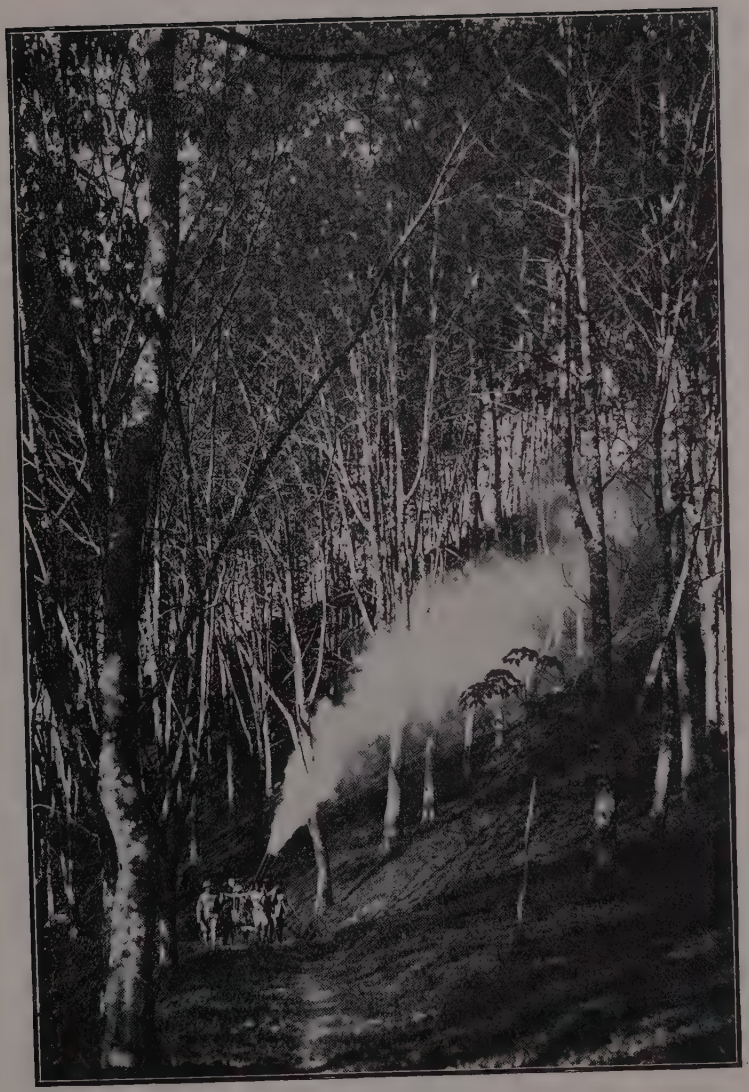

Plate III.

Wind blowing uphill too strong to allow sulphur to rise.

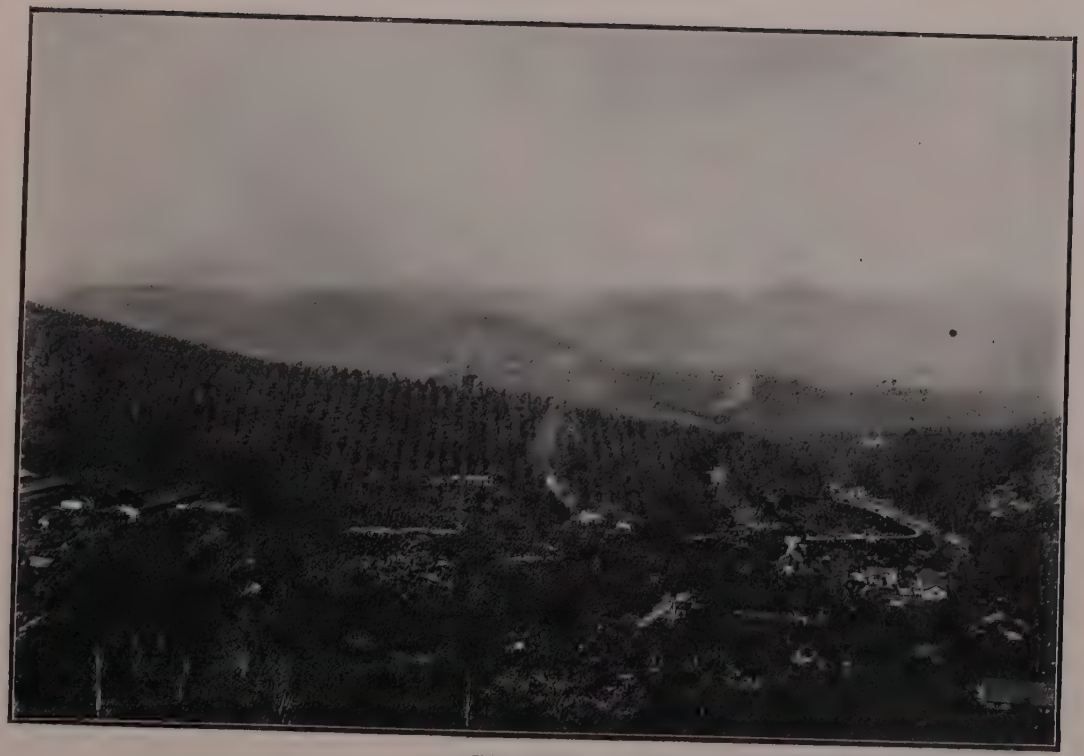

Plate IV.

View of dusting from a distance. Cloud can be seen above trees.

at the same time wafting it slowly through the foliage. Since the breezes are often capricious continually changing in strength and direction, the cloud must be watched most carefully to ensure that every portion of the field receives its full quota of sulphur.

Although it is sometimes possible to dust an appreciable area from one position, the usual procedure is to carry the machine through the field while it is working, the output of sulphur being regulated according to the wind, the slope of the land and the rate of progress. After a little experience it is easy to judge when the required quantity of sulphur per acre is being applied. The quickest distribution is clearly effected when the machine is being moved in a direction at right angles to the prevailing wind, and under such circumstances a belt 50 to 100 yards wide can be treated from one line. Existing roads and paths do not, of course, always suit the wind conditions, and it is often necessary to carry the machine off them. Plates I to IV with their explanatory legends illustrate the process.

The area which can be treated in a full working day is, of course, dependent on the wind conditions in relation to the lie of land and position of the paths, and 100 acres may be taken as an average figure. This rate of progress can be substantially increased by the provision of good roads and paths (see below), but on the other hand under certain conditions the treatment may be a very slow and troublesome process. In an extreme case the difficulties of the land may even render the method impracticable; this possibility is discussed under the heading "Limitations of the Method".

Since the engine runs at a high speed and is only air-cooled, it is advisable, particularly with a new machine, to work in short bursts not exceeding about five minutes in duration. This also enables the men who are carrying the machine to have frequent well-earned rests, and gives an opportunity for replenishing the sulphur box. It is not always necessary actually to stop the engine; the controls can be set so that the engine continues running at a slow speed.

Labour required.—It is usually found inadvisable to start dusting before about 8 a.m. on account of the absence of breezes in the early morning. The labourers can be employed in distributing sacks of sulphur to suitable dumps in the field. A gang of 10 strong men and a kangany is normally sufficient; four to carry the machine, one to be responsible for filling the sulphur box, and the remainder to bring the sulphur to the machine

from the dumps. When the machine has to be taken off paths on to rough land extra labour is thus available to assist in carrying it. Carrying the machine is hard work, and the various tasks should be changed over periodically.

On account of the arduous and unpleasant nature of the work 6 hours with the machine may be considered a full working day, and it is fair that the labourers should receive extra pay in addition to a free issue of soap. If dusting has to be carried out almost continuously throughout the period of refoliation alternative gangs should be employed so as to minimise the possibility of sulphur irritation or poisoning. Sulphur causes a painful smarting in the eyes, and the issue of cheap goggles to the labour gang is advocated.

Filling the sulphur box.—Buckets or kerosene tins fitted with handles are suitable for transporting and feeding the sulphur. When filling the sulphur box great care must be taken not to spill the powder on to the hot cylinder or exhaust pipe. Pure sulphur is readily ignited, and fires may easily be started in this way. It is advisable to delegate the work to one particular man, and to avoid filling the box while the machine is being carried.

A further word of warning in this connection may save considerable trouble. If the sulphur box or hopper is quite empty the slit or slits through which the sulphur falls should be closed before filling, and then re-opened to the desired extent when the engine has been re-started. Otherwise sulphur may fall into the fan chamber in sufficient quantity to prevent the engine being turned over.

Fuel.—All the machines of which the writer has had experience are driven by two-stroke engines lubricated by mixing the oil with the petrol. The oil and petrol should preferably be mixed in a tin before filling the petrol tank. The tank, of course, should be filled before starting work in the morning. The consumption of petrol varies to some extent with different machines and according to the rate of progress, but an average figure may be taken as one gallon of petrol-oil mixture to 70 acres. Thus if the tank is replenished during the mid day interval it is unnecessary to carry petrol and oil in the field.

TIME AND NUMBER OF APPLICATIONS

Finely divided sulphur powder remains active on the leaf as a fungicide for a limited period of time (some 10 to 12 days), and since the foliage must be protected against attack until it

has matured it is clear that a number of periodical applications must be made during the time of refoliation. Dusting the old leaves before they have fallen is of no value, and the first application should be made at the earliest sign of strong Oidium attack on the young leaf produced after the annual winter. The imporance of making careful day-to-day observations at the beginning of the refoliation period, so that the correct time for commencing operations may be judged, is emphasised, for if the start is unduly delayed the results will not be satisfactory.

Ideally, the most even distribution of sulphur and continuity of fungicidal action would probably be obtained by applying a very small quantity of sulphur every day. This, however, is clearly impracticable, and the recommended procedure is to make applications at intervals of 7 to 10 days. 10 days may be regarded as a maximum, and the interval may advantageously be reduced below 7 days, with a corresponding adjustment in the quantity of sulphur per acre, if conditions permit.

The procedure, thus, is to carry out rounds of dusting during the period of refoliation so that every area is treated once in every 7 to 10 days. The number of applications necessary is chiefly dependent on the regularity of the winter and the rate of development of the new foliage. In most districts the early wintering trees escape attack, and at the seven day interval six or seven applications are usually sufficient. If the process of refoliation is unusually protracted, however, the period during which dusting must be carried out will be similarly extended, and the cost of the treatment therefore increased. In parts of Uva, for example, where individual trees shed their leaves almost throughout the year, the treatment is likely to prove more troublesome and less effective than in other districts. The treatment in relation to Uva conditions is discussed in a separate section.

The period between successive applications should be regulated to some extent by the weather conditions. Although finely divided sulphur has good adhesive properties and is not appreciably affected by light rain, a large proportion of the deposit is washed off the leaves by a really heavy downpour. In a normal year in most districts dusting would be carried out during relatively dry weather, but if heavy rain should occur the interval must be decreased. Unseasonable rains may, indeed, seriously impair the efficacy of the treatment, but one can suggest no remedy beyond using a dust with the best possible adhesive properties.

When planning the season's programme it is advisable to allow a margin for wet days and other contingencies such as repairs to the machine. Thus although the average area which can be treated by one machine in a full day has been given as 100 acres, not more than 500 to 600 acres should be allotted per machine. An estate, for example, of 1000 acres should possess two machines.

QUANTITY OF SULPHUR PER ACRE

The minimum effective quantity of sulphur per acre per application depends largely on the intensity of the anticipated attack. With a seven-day interval 10 lb. per acre per application may be regarded as a maximum dose for the most severely affected areas. With a longer or shorter interval the quantity is increased or decreased proportionately. It may be possible to economise in sulphur by using a somewhat smaller quantity for the first and last applications when the fungus may not be at full virulence or the proportion of trees in young leaf may be small.

It is clear that no figure for the total quantity of sulphur required per acre during the dusting season can be given to cover all cases. Under the conditions in which the treatment is likely to be undertaken the quantity will probably lie between 35 and 75 lb. Since sulphur will keep from one year to the next (though "Flotate" Sulphur would need re-drying) it is advisable to allow for a substantial margin over the anticipated consumption.

It should, perhaps, be mentioned that the figures given above are based on accumulated field observations rather than on any data from comparative trials. It is hoped that a series of large-scale experiments to be carried out in 1935 will shed light on the best grade of sulphur and the minimum effective quantity per acre.

SUPERVISION

The importance of careful and intelligent supervision of the treatment in the field must be emphasised. Under normal conditions sulphur dusting is not a difficult process, but it will give disappointing results unless it is ensured that every portion of the field receives its full quota of sulphur. Since this cannot be checked by subsequent inspection the supervision must be exercised at the time of dusting. Constant supervision by the Superintendent himself is considered essential. When dusting becomes a routine measure on the estate it may be satisfactory to delegate the work largely to an intelligent subordinate, but it

will always be necessary for someone to be present with an elementary knowledge of the internal combustion engine. It has been found that engine stoppages due to minor causes such as a blocked carburettor jet, dirty or faulty sparking plug, etc. are fairly frequent, and the work will be greatly delayed unless someone with the machine is capable of diagnosing and rectifying the trouble.

ROADS

The sulphur dusting operation could undoubtedly be facilitated and expedited by the provision of a network of roads strategically placed in relation to the prevailing direction of the breezes so that it would seldom be necessary to carry the machine off them. The machine could then be mounted on a hand cart or even a "baby" lorry. The extent to which such special "roading" is feasible depends, of course, on the type of land, but if sulphur dusting is to be an annual routine measure it would certainly be advisable at least to improve existing paths so that the machine can be placed on some type of wheeled vehicle. Whether the machine is to be placed on wheels or not, there is no doubt that in certain areas the existence of suitably placed paths would be the determining factor in the practicability of the treatment. Reference to the details of costs given below show that sulphur is the only expensive item, and it might thus be concluded that the speed of the work is unimportant. It must be remembered, however, that owing to the necessity for constant supervision the treatment makes heavy demands on the Superintendent's time, and if the progress were too slow it might be impossible to work to a satisfactory programme over a large area.

COSTS

The initial outlay on a dusting outfit is about Rs. 1,200/-. It is difficult to fix a working life for this type of machine, but one might suggest writing off the cost in four years.

Representative figures for the costs of one application over 100 acres (assumed to be one day's work) are given below. The chief item is sulphur, the costs being thus largely dependent on the grade used. As representative of the two classes of dusting sulphur mentioned in an earlier section the following prices may be given:

No. 1 Quality Sulphur from Java Rs. 168/- per ton f.o.r. Colombo.

Specially Prepared Dust Rs. 230/- per ton f.o.r. Colombo.

The figures given below are based on the assumption that the inexpensive "Java" product is used. There is at present no evidence that the higher cost of the special preparations can be offset by lower quantities, but, as mentioned above, the Java

product is not always in an ideal physical condition. The small item for drying the sulphur would not be included if a specially prepared dust were used.

	R. c.
Sulphur.—800 lbs. @ - 09 (including transport and handling charges). ...	72 00
Labour.—11 coolies dusting @ - 55. ...	6 05
3 coolies drying sulphur @ - 40.	1 20
Running Expenses.—1¼ galls. petrol-oil mixture	2 50
Proportion of expenses for minor repairs to machine and incidentals, say ...	2 00
	83 75

On the basis of six applications during the season the cost per acre per annum would thus be approximately Rs. 5 -.

SULPHUR DUSTING IN UVA

The procedure outlined in the preceding sections must be modified to some extent in localities where the irregularity of the natural winter is responsible for the production of young leaves over a very long period. Such conditions occur in particular at the higher elevations in Uva and may prove a serious obstacle to the success of the treatment on a practical scale. The writer has had experience of dusting on two estates in Uva in 1930 and 1931 respectively: on both estates the treatment was undoubtedly beneficial though the results were less striking than those obtained elsewhere. This comparative failure was due to the fact that the dusting operations did not completely cover the period of refoliation, and special measures would appear to be necessary when combating Oidium under these conditions.

Maintaining the interval of 7 to 10 days between successive rounds, it is clear that the number of applications must be increased beyond the six or seven sufficient for most districts. If the cost of the treatment is to be kept within reasonable bounds the quantity of sulphur used per acre per application must be reduced to accord with the smaller quantity of young leaf present at any one time, and this implies the ability to concentrate the fungicide particularly on those trees with new foliage. The writer has no experience of such a procedure but it is considered that provided the total area to be treated is not sufficiently large to necessitate rapid progress, it will be practicable to a limited extent. It is not suggested that each individual tree which winters "out of season" throughout the year be treated, but if satisfactory results are to be obtained dusting must be carried out at any time at which a large quantity of young leaf is developing during a period of Oidium activity.

Plate V.

Dusted area after six applications of sulphur. Contrast with Plate VI. (14 3 31).

Plate VI.

Adjoining control (undusted) area. Contrast with Plate V. — (14-3-31.)

There is little doubt that under such conditions the sulphur dusting treatment will be more troublesome, more expensive and less effective than in other districts, but an attempt to control the disease on the lines suggested above would appear to be the only alternative to the ultimate devastation, or at least permanent deterioration, of the severely affected areas in Uva.

LIMITATIONS OF THE METHOD

Lest it be thought sulphur dusting is a treatment by means of which Oidium can be completely eradicated, or even defoliation entirely prevented, some reference must be made to the limitations of the method.

Sulphur is an extremely toxic substance to powdery mildew fungi, and there is little doubt that if a good covering of sulphur powder could be maintained on both surfaces of every leaf during the period in which the fungus is active, all infection would be stopped and the foliage would be 100% healthy. Such are the practical difficulties, however, of dusting tall trees on hilly land that entirely effective control is not, nor, indeed, is ever likely to be, possible of achievement. All that can be expected of the treatment is the prevention of the greater part of the abnormal defoliation. When dusting is discontinued the fungus may still be active, but since the majority of the leaves are by this time mature the attack will only cause spotting, and not leaf-fall. The fungus has not been eradicated and will again become active during the next refoliation season. The sulphur dusting treatment must therefore be regarded as an annual routine measure, though it is possible that by co-operative work the quantity of infective material, and thus the cost of the dusting, may be reduced in successive years.

Plates V and VI have been included to show the measure of improvement that can be obtained in a severely affected locality.

It has been suggested in a previous section that on exceptionally difficult land dusting may not be a practicable proposition. Thus on a steep hill side whose contours are in a line with the direction of the prevailing wind it will be difficult to obtain an even distribution of sulphur unless there are numerous "zigzag" paths fairly close together. There is a limit to the gradient of the land on which the machine can be carried, but the provision of sufficient paths would usually appear to provide a solution of the problem. It would seem, however, that on such land dusting from the air would be the logical procedure, and preliminary enquiries regarding a suitable type of aeroplane are being made.

TAINT OF TEA

The possibility of sulphur drifting on to neighbouring Tea fields and thus causing taints is an important matter in Tea-cum-Rubber districts. Investigations carried out by the Research

Scheme when sulphur dusting was first introduced indicated that the quantity of sulphur which might fall on adjoining Tea despite careful work was insufficient to cause any taint. Several tests were carried out, sulphur being purposely allowed to fall on the Tea, but although a smell was always noticeable during manufacture, in no instance was any taint detected by tasters in the final product. The occurrence of taint is, of course, determined mainly by the quantity of sulphur falling on the bushes, and the Tea Research Institute has kindly undertaken to carry out a series of critical quantitative tests. Until the results are available the matter must be considered *sub judice*, but in the meantime it may confidently be asserted that as long as reasonable care is taken in the neighbourhood of Tea fields the possibility of taint does not constitute a serious objection to the treatment.

SUMMARY

A short summary of the recommended procedure for the dusting treatment may prove useful for quick reference.

(1). Start dusting at the first sign of strong Oidium attack on the young leaf produced after the annual winter.

(2). Thereafter make periodical applications so that each field is treated regularly once in 7 to 10 days. The interval should not exceed 10 days but may advantageously be reduced below 7 days if feasible.

(3). At a seven day interval 10 lb. of sulphur per acre per application may be regarded as a maximum dose in the most severely affected areas. The quantity should be adjusted according to the anticipated severity of attack, the interval between applications and, under certain circumstances, the amount of young leaf present.

(4). Stop dusting as soon as the bulk of the foliage has matured. The period during which dusting has to be undertaken is clearly dependent on the regularity of the winter and the rate of maturation of the leaves, and no definite figure can be given for the number of applications necessary.

REFERENCES

1. Rubber Research Scheme *Quarterly Circular*, Vol. 7, Part 2, 1930 p. 28.

2. Rubber Research Scheme *Quarterly Circular*, Vol. 7, Part 4, 1930, p. 88.

3. Rubber Research Scheme *Quarterly Circular*, Vol. 8, Parts 2 and 3, 1931, p 17.

4. Rubber Research Scheme *Quarterly Circular*, Vol. 8, Part 4, 1931, p. 42.

5. Rubber Research Scheme *Quarterly Circular*, Vol. 10, Part 1, 1933, p. 1.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the twenty-first meeting of the Board of Management held at 11 a.m. on Thursday, May 17, 1934, in Room No. 213, New Secretariat, Colombo.

Present.—Dr. W. Youngman (in the chair), Messrs. C. H. Collins (Deputy Financial Secretary), L. B. de Mel, J.P.,U.P.M., H. R. Freeman, M.S.C., L. P. Gapp, F. H. Griffith, M.S.C., Col. T. G. Jayewardene, V.D., M.S.C., Messrs. J. L. Kotalawala, M.S.C., F. H. Layard, P. R. May, F. A. Obeyesekere, M.S.C., C. A. Pereira, B. M. Selwyn, E. C. Villiers, M.S.C., and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director of Research, was present by invitation and acted as Secretary.

Apology for absence was received from Mr. C. E. A. Dias, J.P., and from Mr. B. F. de Silva.

BOARD

The Chairman reported the following changes in membership of the Board:—

(a) Nomination of Mr. L. B. de Mel, J.P.-U.P.M., in place of Mr. A. E. de Silva who had resigned.

(b) Renomination of Mr. I. L. Cameron for a further period of 3 years from April 25, 1934.

(c) Nomination of Mr. F. H. Layard to act for Mr. I. L. Cameron during his absence on leave, with effect from May 8th.

(d) Nomination of Mr. C. H. Z. Fernando to take the place of Mr. F. A. Obeyesekere on completion of the latter's 3 year period of office on May 29, 1934.

The Chairman welcomed new members to the Board and took the opportunity of thanking those who were retiring for their services.

OIDIUM LEAF DISEASE

Consideration was given to proposals for future experimental work on *Oidium*, which provided for (a) a sulphur dusting experiment over an area of 100 acres in the Kalutara District (b) co-operation with estates in trials of different brands of sulphur, maximum effective quantity per acre and optimum interval between successive applications (c) lectures and demonstrations to District Planters' Associations (d) the issue of a leaflet giving practical information to assist estates undertaking sulphur

dusting (e) preliminary enquiries regarding the possibilities of dusting from aeroplanes. The proposals were adopted and funds voted for the necessary expenditure in the current year.

STAFF

(a) The Chairman reported that Mr. M. W. Philpott had arrived in Ceylon on May 7th and that his agreement would date from April 13, 1934, the date of embarkation for Ceylon.

(b) The appointment of Mr. C. D. de Fonseka as Secretary to the Director of Research from April 3, 1934, was reported.

BUILDINGS AT DARTONFIELD

(a) *Experimental Factory.*—A recommendation of the Estate Committee to provide 3 additional bays in the experimental factory at an extra cost of Rs. 6,000/-, was approved. The Director of Research reported that he expected to have the factory site and approach road ready by June 15th.

(b) *Chemist's Laboratory.*—Proposals were considered for the erection of a laboratory and equipment with power connections and batteries, petrol gas plant, water supply, benches etc., at an estimated cost of Rs. 23,882/-. An inclusive vote of Rs. 25,000/- was approved and the Estate Committee was authorized to make decisions regarding the acceptance of tenders and to proceed with the work.

RUBBER RESEARCH SCHEME (CEYLON)

LIST OF PUBLICATIONS FOR SALE.

Bulletins No. 1-20. Bound volume **Rs. 5-00. Later Bulletins Re. 1-00** per copy

No. 1. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 2. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 3. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis Part I.
No. 4. The Physiological Effects of Various Tapping Systems, Part I.
No. 5. Progress Report on Vulcanization Tests
No. 6. The Physiological Effects of Various Tapping Systems, Part II.
No. 7. Do Do Do Part III
No. 8. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis, Part II.
No. 9. Vulcanization Tests.
No. 10. Do.
No. 11. Variability in Rubber Manufacture.
No. 12. Progress Report of the Rubber Research Chemist.
No. 13. Vulcanization Tests.
No. 14. On the Variation in the Number of Latex Vessels present in Hevea brasiliensis.
No. 15. Vulcanization Tests.
No. 16. On the Natural Clotting of Rubber Latex.
No. 17. Vulcanization Tests.
No. 18. Measurements of "Bark Renewal."
No. 19. Vulcanization Tests.
No. 20. Do.
No. 21. Do.
No. 22. Do.
No. 23. Do.
No. 24. Do.
No. 25. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 26. Results of Trials of Ceylon Plantation Rubber for the manufacture of Ebonite.
No. 27. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 28. Do.
No. 29. Summary of the Principal Results obtained from Investigations into the Properties of Ceylon Plantation Rubber in relation to its Method of Preparation.
No. 30. The penetration of disinfectant on the tapping cut of Hevea brasiliensis.
No. 31. On the Occurrence of "Rust" on Sheet Rubber.
No. 32. On the Preservation of Latex.
No. 33. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 34. Do.
No. 35. Do.
No. 36. Do.
No. 37. Do.
No. 38. Do.
No. 39. Do. (Final Report Series I.)
No. 40. Do Series II.
No. 41. Do. First Interim Report on artificial ageing tests.
No. 42. On the Smoking of Sheet Rubber in relation to Mould Prevention.
No. 43. The Inter-relationship of Yield and the various Vegetative Characters in Hevea brasiliensis. (out of print).
No. 44. The Construction of Smokehouses for Small Rubber Estates. (out of date).
No. 45. The Efficiency of Disinfectants and Fungicides.
No. 46. The Control of Bark Rot by Disinfectants.
No. 47. Report on Variability of Ceylon Estate Grades.
No. 48. Brown Bast and its Treatment.
No. 49. Report on Causes of Variation in Plasticity.
No. 50. Crepe Rolling.
No. 51. The Curing of Sheet Rubber.
No. 52. The Preparation of Uniform Rubber.

Booklets at Rs. 2-50 per copy.

Guide to the Preparation of Plantation Rubber, by T. E. H. O'Brien, M.Sc., A.I.C., Chemist.

The Budding of Rubber, by R. A. Taylor, B.Sc., Physiological Botanist. (out of date).

Diseases of Rubber in Ceylon, by R. K. S. Murray, A.R.C.Sc., Mycologist.